THE ROLE OF SYNCHROTRON RADIATION BASED X-RAY MICROTOMOGRAPHY IN EXAMINATION OF SMALL EXTRATERRESTRIAL SAMPLES RECOVERED BY SPACECRAFT IN THE STARDUST AND HAYABUSA MISSIONS.

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Introduction: Coma dust particles of comet 81P/Wild 2 coma were returned to Earth by NASA's Stardust mission in January 2006 and have been examined in laboratories [1]. Regolith particles of Asteroid 25143 Itokawa were returned by JAXA's Hayabusa mission in June 2010 and preliminary examination has started [2,3]. Particle sizes of both the samples are small (<~100 μm) and their total amounts are very small compared with Apollo lunar samples. Non-destructive microtomography gives unique 3D data and also plays an important role in later destructive analyses in order to optimize the information obtained from these small, precious particles. Our research group has used a synchrotron radiation (SR) based microtomography system for these samples. An overview of these results will be presented here.

SR-based microtomography: Tomography using X-ray absorption is a conventional method to give spatial distribution of X-ray linear attenuation coefficients (LACs) as a digital image (CT image). SR X-ray beams with high flux density and high coherence gives CT images of high spatial resolution (nano-scale resolution is possible by X-ray microscope optics using a FZP) and high S/N ratio. High flux X-ray beams are easily monochromated, and this gives quantitative LAC values in CT images, which can be used for identification of minerals and their rough chemical compositions. We used microtomography systems at BL20B2 and BL47XU of SPring-8 for the sample examination.

Stardust samples: Comet coma dust was captured using silica aerogel at a relative velocity of 6.1km/sec by the Stardust spacecraft.. Dust particles were disrupted during the capture and impact tracks were formed. Relatively coarse crystalline grains, harvested from impact tracks, were examined by microtomography, which determined how to best cut the sample particles for later oxygen isotope analysis [4]. 3D morphologies of impact tracks were also examined, and densities of impacted dust particles were estimated based on these data [5].

Hayabusa samples: A quantitative 3D mineral distribution was obtained for each particle by imaging at 7 and 8 keV. These 3D mineral maps were essential for planning later destructive analysis in the preliminary examination analysis flow. External 3D shape features of these particles were also examined to reveal details of regolith formation and evolution on Itokawa [3].

References: [1] Brownlee D. E. et al. 2006. *Science* 314:1711-1716. [2] Nakamura T. et al. 2011 This abstract. [3] Tsuchiyama A. et al. 2011 This abstract. [4] Nakamura T. et al. 2008. *Science* 321:1664-1667. [5] Iida Y. et al. *Meteoritics & Planetary Science*, 45:1302-1319.